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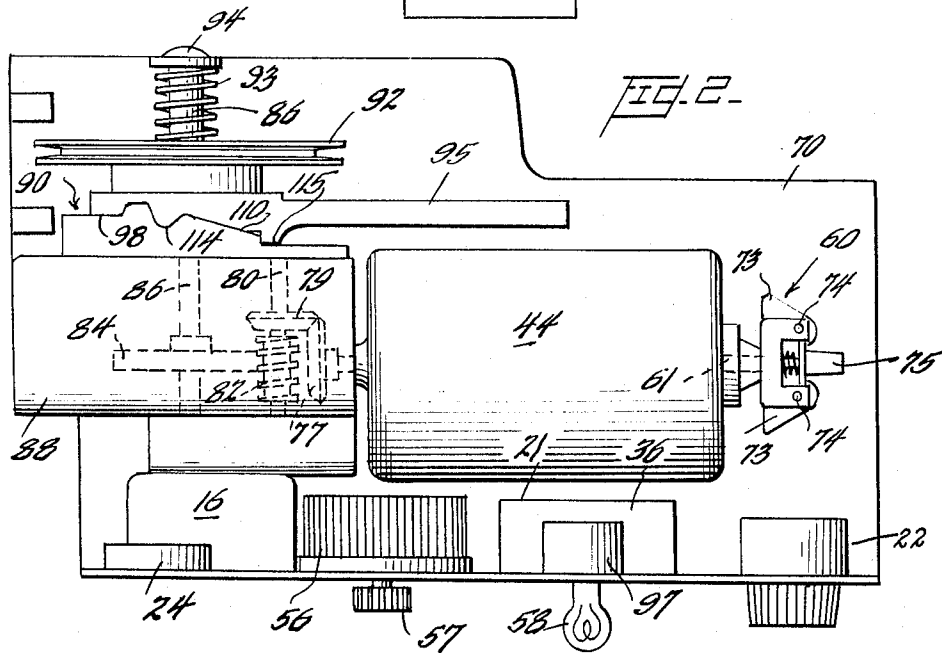
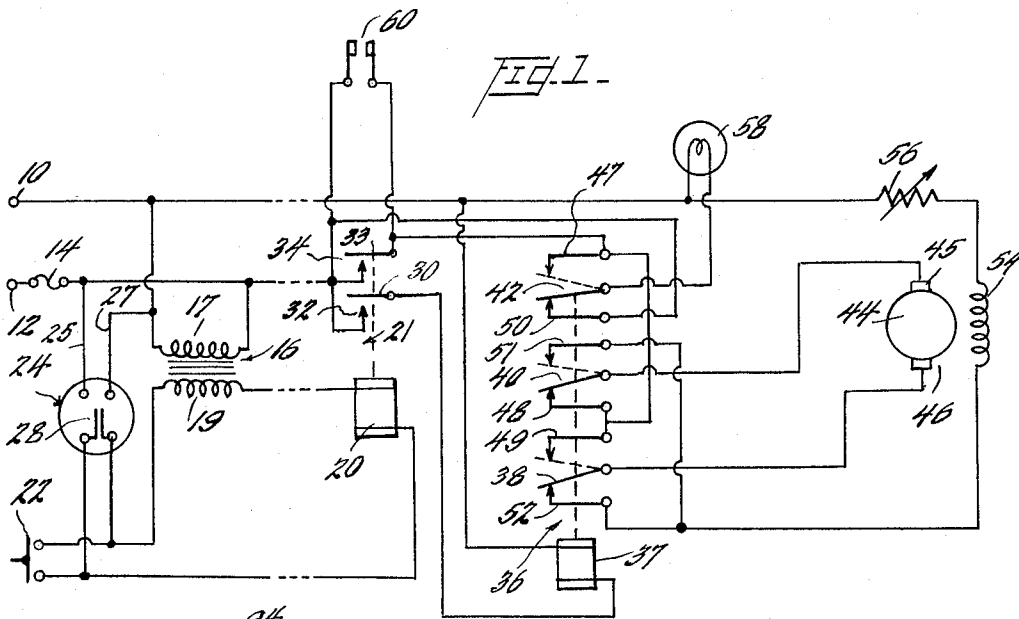
T. M. STEPHENS

3,287,618

CLOSURE OPERATOR

Original Filed Jan. 2, 1962

2 Sheets-Sheet 1



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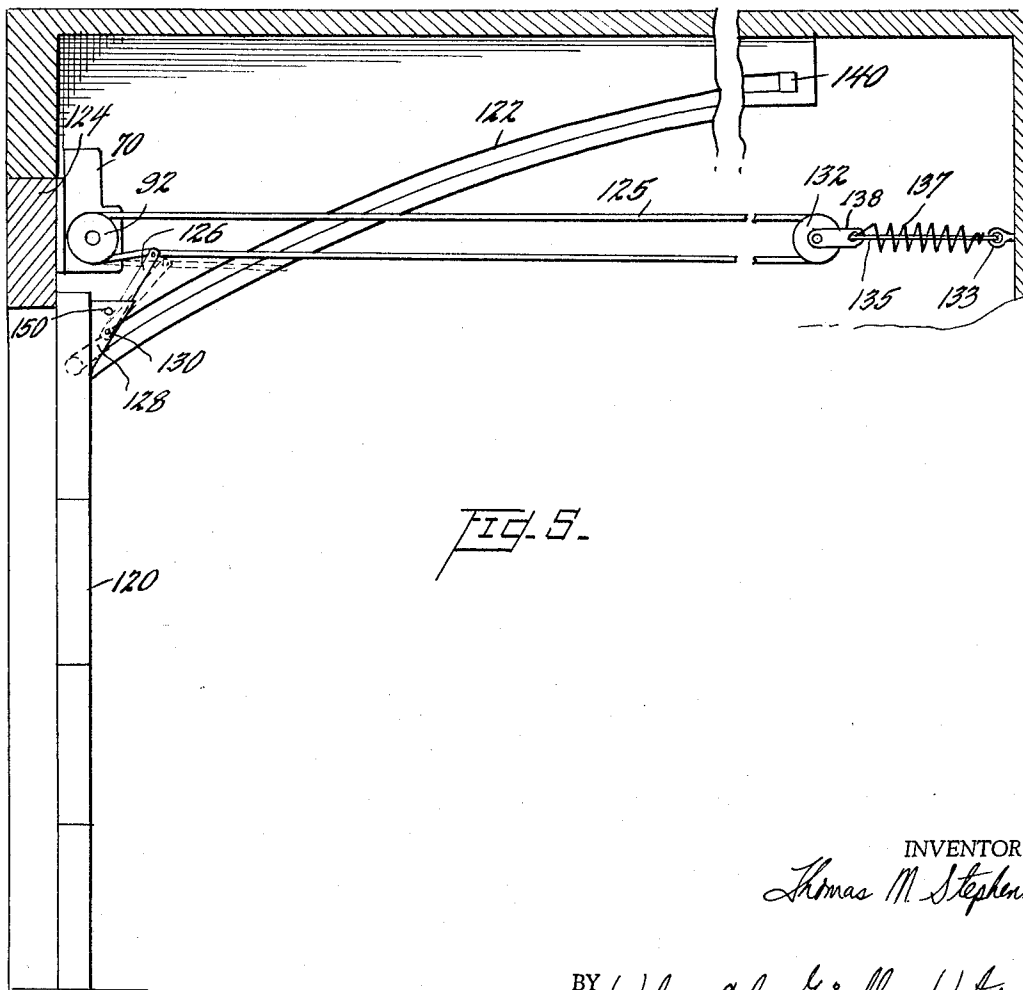
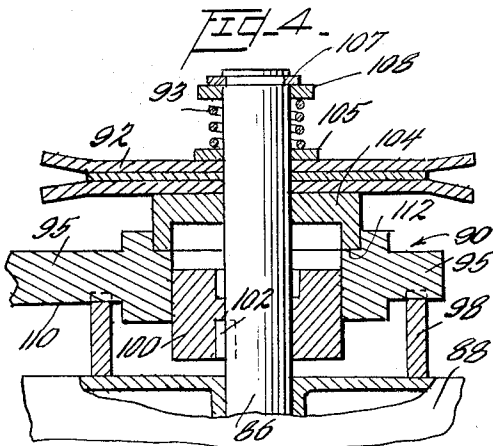
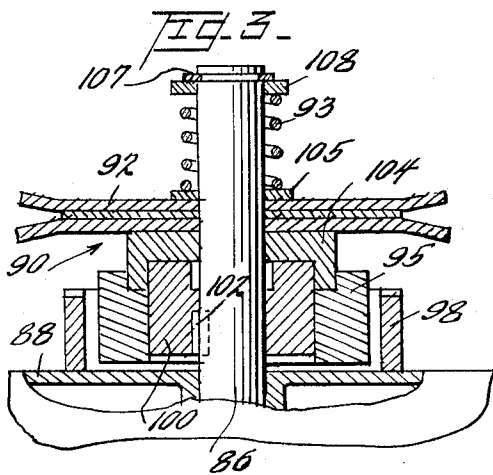
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CLOSURE OPERATOR

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Continuation of application Ser. No. 163,705, Jan. 2, 1962. This application Aug. 4, 1965, Ser. No. 480,240
2 Claims. (Cl. 318—267)

This is a continuation of the copending application, Serial No. 163,705, filed January 2, 1962, now abandoned.

This invention relates to closure operations and more particularly to an electrically operated closure operator.

Priorly numerous forms of electrically operated closure operators have been employed. These known types of devices, however, exhibit numerous disadvantages. For example, they are very complex in construction and operation. They do not include safety features; or, if these safety features are included, they require additional circuits and mechanisms. Most of the prior art devices require limit switches to control the limits of movement of the closures and further require positive locking and de-clutching of the electric motor when the closure stops.

Accordingly, it is an object of this invention to provide an improved closure device.

It is another object of this invention to provide an electric closure operator which does not require limit switches to stop the operator when the closure reaches its terminal positions.

It is another object of this invention to provide an electric closure operator with a motor which automatically stops when the closure meets an obstruction such as a person.

It is another object of this invention to provide an electric closure operator with a variable speed and sensitivity control which limits the speed of the electric motor and controls the sensitivity of the motor to obstructions in the path of the closure.

It is another object of this invention to provide a closure operator which performs all the necessary functions with a minimum of parts.

It is another object of this invention to provide an electric closure operator which positively drives the closure in both directions of travel with a substantially constant force throughout the travel.

It is another object of this invention to provide an electric closure operator with a light which operates automatically in conjunction with the closure, which light may also be operated independently of the closure.

It is another object of this invention to provide an electric closure operator with an electric light, which closure operator may be controlled by a single switch which switch controls the closure operator and selectively controls the light.

It is another object of this invention to provide an electric closure operator with an arrangement for manual operation of the closure in the event of power failure.

It is another object of this invention to provide an electric closure operator with a light and an energizing circuit for the light which automatically turns the light on when the closure starts to open and continues to energize the light until the closure is completely closed.

Briefly, in accordance with aspects of this invention, a closure operator is provided with a reversible electric motor and a ratchet or stepping relay for controlling the motor which relay reverses the connections between the motor and the power source each time the relay is energized. Advantageously, the relay includes contacts which are connected to a light so that the light is connected to the power source while the motor is running and during the time that the closure is in its opened condition. Also advantageously, the energizing circuit of the motor includes

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a serially connected centrifugal switch and start relay contacts connected in parallel with the centrifugal switch. Actuation of this start relay will energize the reversible motor and when the motor reaches a predetermined speed, the centrifugal switch will close thus short-circuiting the previously mentioned start relay contacts. Whenever the closure engages an obstruction, the motor will be slowed down causing the centrifugal switch to open and the motor to stop. The centrifugal switch therefore acts as a limit switch for the terminal positions of the closure and also acts as a safety device to disconnect the motor when the closure engages an obstruction such as a person. The start relay also includes a separate armature for controlling the circuit of the motor control relay. The motor circuit advantageously includes a motor current control device which controls the motor speed and also controls the sensitivity of the operator safety feature which stops the motor when an object is contacted. In the preferred embodiment, this current control device is a rheostat serially connected with the motor field winding.

In the preferred embodiment, a single position button switch is connected to a transformer which is coupled to the power source to the start relay winding selectively to control the energization of the start relay. Since the start relay controls both the motor control relay and the energizing circuit of the motor, it is possible to momentarily actuate the start relay to cause the motor control relay to be energized and turn the light on without energizing the motor for a sufficient period to allow the motor to attain running speed and thereby close the centrifugal switch. Thus the light may be turned on without causing the motor to actuate the closure. Advantageously, the motor control relay is a ratchet or latching type relay with a stepping type arrangement which positively moves the associated armatures to one of two positions when the relay winding is momentarily energized.

In accordance with other aspects of this invention, the motor is connected to drive the closure through a gear train which includes a worm and wheel gear such that the closure cannot be manually moved when the motor is stopped because of the high gear ratio provided by the worm and wheel. Thus the instant arrangement provides positive locking of the closure when the closure reaches its terminal positions merely by releasing the centrifugal switch which operation de-energizes the motor.

In accordance with still another aspect of this invention, a clutch is provided between the gear train and the cable drive wheel which drives the closure, which clutch has an arm mounted thereon for manual disengagement of the coupling between the motor and the reel upon power failure.

These and various other aspects and features of the invention will be more clearly understood from a reading of the detailed description of the invention in conjunction with the drawing in which:

FIGURE 1 is a schematic diagram of the electrical circuit of one illustrative embodiment of this invention;

FIGURE 2 is a pictorial diagram of the illustrative embodiment of this invention;

FIGURE 3 is a view, partly in section, to a larger scale of the closure arrangement showing the clutch in an engaged position;

FIGURE 4 is a view, partly in section, also to a larger scale of the closure arrangement showing the clutch in a disengaged position; and

FIGURE 5 is a side view to a reduced scale of a typical installation of the closure operator.

Referring now to FIGURE 1, there is depicted in schematic form the circuit of one illustrative embodiment of this invention. As therein depicted, a pair of power input terminals 10-12 are connected to a suitable source of supply (not shown). Connected to terminal 12

is a fuse 14 which is a conventional current overload safety device. A transformer 16 has its primary winding 17 connected across the power source on the side of fuse 14 remote from input terminal 12. The secondary winding 19 of transformer 16 defines an energizing circuit for a winding 20 of relay 21. The energizing circuit includes a suitable switch such as push-button switch 22. A remote control plug 24 has two leads 25 and 27 connected across the input source for energizing a remote switching device which, in turn, controls a remote control switch, indicated as switch 28, which is connected in parallel with push button switch 22. Thus the remote control operator may actuate the remote control switch to produce the same results as if the push-button switch were actuated.

Relay 21, which will be designated as the first or start relay or as the push-button control relay, has a first armature 30 positioned to engage a first stationary contact 32 and a second armature 33 positioned to engage a second stationary contact 34. A second relay 36, which is a ratchet or stepping-type relay, will sometimes be designated as the motor and light control relay and has a winding 37 connected to input terminal 10. The other side of winding 37 is connected to armature 30 of the first relay. Since stationary contact 32 of relay 21 is connected to input terminal 12 through fuse 14, winding 37 will be energized when winding 20 is energized and pulls armature 30 into engagement with contact 32.

Advantageously, the second or motor and control relay is a latching type or stepping-switch type of relay, which moves its associated armatures 38, 40 and 42 into one of their two positions each time the relay is energized. Armatures 38, 40 and 42 will be mechanically held in this position until winding 37 is again energized, at which time armatures 38, 40 and 42 will be moved to their other contact engaging position and mechanically held in that position. This type of latching or ratchet relay is well known and it is therefore unnecessary to describe the mechanical details.

Armatures 38 and 40 are connected to the armature of reversible motor 44 through suitable brushes 45 and 46. Stationary contacts 47, 48 and 49 of relay 36 are connected to armatures 33 of start relay 21. Stationary contact 50 is connected to power input terminal 12 through fuse 14 and will be energized at all times. Stationary contacts 51 and 52 of relay 36 are connected through the field winding 54 of motor 44, rheostat 56, to power input terminal 10. A light 58 is connected between armature 42 of relay 36 remote from power input terminal 10. A centrifugal switch 60 is connected in parallel with stationary contact 34 and armature 33 of relay 21. This centrifugal switch is mounted on the rotor shaft of motor 44 in a manner well known in the art. It is, of course, understood that any other form of speed responsive switch may be employed to accomplish the same purpose.

Referring now to FIGURE 2, there is depicted a pictorial plan view of one illustrative embodiment of this invention. As therein depicted, a housing 70 has the reversible motor 44 mounted thereon by suitable means such as by bolts (not shown). The centrifugal switch 60 is mounted on the shaft 61 of motor 44 in a manner well known in the art, and the switch includes a centrifugal switch actuator having fly weights 73 mounted for swinging movement about pivot pins 74. When the motor reaches a predetermined speed, such as 2,000 r.p.m., the fly weights 73 pivot about pins 74 against the action of a spring, not shown, to move nylon sleeve 75 to the left, as viewed in FIGURE 2, permitting the contacts of centrifugal switch 60 to close. If at any time the motor speed is reduced below this predetermined value of 2,000 r.p.m., the springs (not shown) will force the fly weights 73 to return to the position shown in FIGURE 2 and thus return the sleeve 75 to a position in which it opens the contacts of switch 60.

Mounted on the opposite end of the shaft 61 is a spur pinion 77 which engages a spur pinion 79 rotatably mounted on a shaft 80. Also mounted on a shaft 80 and secured to spur pinion 79 is a worm gear 82. Worm gear 82 engages a wheel gear 84 secured to output shaft 86. The shaft 86 is rotatably mounted on the gear train housing 88 and extends through the housing to a clutch arrangement 90 and is thereby coupled to cable drive reel 92. Cable drive reel 92 is rotatably mounted on shaft 86 and is held in engagement with clutch arrangement 90 by means of clutch spring 93, which clutch spring is held in position by a washer and locking ring arrangement 94 on output shaft 86 in a manner which will be described in detail below. The operation and connection between the cable drive wheel 92 and the closure will also be described subsequently.

A clutch arm 95 has a portion which encircles the output shaft 86 and a clutch cam surface 96 is secured to the gear train housing 88 to cooperate with the clutch arm actuation of the arm 95 disengages the clutch 90 and thus disconnects the motor from the cable drive reel thereby permitting normal manual operation of the closure.

The light 58 is shown mounted in a light receptacle 97 secured to the upper wall of housing 70, as viewed in FIGURE 2. Relays 21 and 36 are also mounted on the upper wall of housing 70. Rheostat 56 is mounted on the upper wall of housing 70 with its control handle 57 projecting through the panel for easy manual adjustment. Transformer 16 is also shown mounted on the upper wall of housing 70 and remote control plug 24 is mounted adjacent the transformer 16. It is, of course, understood that the specific location and mounting of the electrical components are not critical and any convenient mounting arrangement may be permitted. For simplicity, however, it is particularly advantageous to have all of the operator components mounted on a unitary housing to facilitate installation and wiring in production by eliminating all unnecessary connections. With the embodiment shown in FIGURE 2, the only external connections will be the power source connected to terminals 10 and 12, the cable drive connected to reel 92, the push-button or similar switch 22 and remote control plug 24 (when desired) connected to suitable terminals (not shown).

Referring now to FIGURE 3, there is depicted to a larger scale a view, partly in section, of the details of the clutch and the cable drive reel. The clutch assembly 90 includes a clutch cam 98 bolted or otherwise secured to the gear train housing 88, and a clutch throwout arm 95 which has an annular portion which encircles the output shaft 86 and rotates within clutch cam 98. A male clutch dog 100 is keyed to output shaft 86 by means of key 102 and the clutch dog 100 engages a female clutch dog 104 which is riveted or otherwise secured to the cable drive reel 92. A washer 105 is positioned adjacent the outer surface of drive reel 92 in a position to engage helical spring 93 which encircles output shaft 86. The locking ring 107 and the washer 108 are part of the locking assembly 94 which retains the clutch spring 93 on the output shaft 86. Since the clutch dog 100 is shown engaged with the clutch dog 104, it will be understood that the clutch is shown in its engaged position. In other words, in the position shown, rotation of the output shaft 86 by means of the motor 44, shown in FIGURES 1 and 2, will rotate the cable drive reel 92.

As shown in FIGURE 4, the clutch assembly 90 is in its disengaged position. Clutch arm 95 has been rotated to a position in which its cam surface 110 engages clutch cam 98 thus causing the clutch arm 95 to be translated to the right as viewed in FIGURE 4. As the clutch arm 95 moves to the right, the shoulder 112 engages the surface of the female clutch dog 104, moving the female clutch dog 104 to the right, as viewed in FIGURE 4, thereby disconnecting the female clutch dog 104 from the male clutch dog 100. The cable drive reel 92 is now free to

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rotate relative to shaft 86 to permit manual movement of the closure. It is understood that the clutch throwout arm 95 is normally in its engaged position, as shown in FIGURE 3, and is only employed to disconnect the motor 44 from the drive reel 92 in the event of a power failure or malfunction of the operator to permit the closure to be manually operated. Advantageously, the clutch cam 98 contains a notch 114 in a position to receive a finger 115 extending from clutch arm 95 when the clutch arm is rotated to a clutch disengaged position. The cooperation of the notch 114 and the finger 115 will retain the clutch arm in a clutch disengaging position.

Referring now to FIGURE 5, there is shown to a greatly reduced scale a typical installation of one illustrative embodiment of this invention. As therein depicted, a closure such as an overhead-type of garage door (either tract of jam-type hardware) 120 is shown which slides along tracks such as track 122. The unitary housing 70 is mounted on the sill 124 above the door opening and is connected to the closure 120 by means of a cable 125, a hitch arm 126 connected to the cable and pivotally secured to door 120 by means of bracket 128 and bolt 130. Cable 125 passes around a pulley 132 secured to the interior of the garage by means of an eye bolt 133. The eye bolt 133 is connected to the pulley 132 by means of a rod, cable or chain 135, and a limit spring 137 connected between the rod and the pulley sheave 138. This flexible linkage defined by the rod, cable or chain 135 and the limit spring 137 maintains the cable 125 under sufficient tension at all times to provide a good positive connection between the drive reel 92 and the door 120. This linkage permits variation in the distance between the door 120 and the cable 125, which variation takes place during the opening and closing movements as the door passes along the track 122 from a position below the cable 125 to a position below the cable 125 to a position above the cable 125.

An important feature of the connection between the closure operator and the closure is the pivotal connection between hitch arm 126 and the bracket 128 defined by bolt 130. When the drive reel 92 operates to open closure 120, arm 126 pivots through a relatively small angle, for example 10° to 20° . This pivotal connection prevents cable 125 from becoming slack between reel 92 and hitch arm 126 immediately before closure 120 starts to move. Since arm 126 is pivoted at bolt 130, spring 137 takes up this slack. A stop bolt 150 is fastened in bracket 128 and prevents arm 126 from hitting reel 92 when closure 120 is closed.

The overall operation of the closure operator will now be described in detail. Assume for a moment that the closure is closed as shown in FIGURE 5, armatures 38, 40 and 42 of relay 36 are in their dotted line position shown in FIGURE 1 and the push-button 22 shown in FIGURES 1 and 5 is released. As shown in FIGURE 1, the energizing circuit through the secondary winding 19 of transformer 16 will be completed through winding 20 of relay 21 when push-button 22 is depressed. When winding 20 is energized, armatures 30 and 33 are attracted to engage contacts 32 and 34, respectively. When armature 30 engages contact 32, relay winding 37 of relay 36 is connected across the power input terminals 10 and 12, causing the armatures 38, 40 and 42 to move to their solid line position shown. Under these conditions, energized current is supplied from terminal 12 through a stationary contact 50 to armature 42 and the light 58. Current also passes through armature 33 to stationary contact 48 which is connected to armature 40, thereby supplying current to the rotor of motor 44 through brushes 45 and 46, armature 38, and stationary contact 52. From contact 52 the rotor current flows through motor field winding 54 and rheostat 56 to terminal 10.

If the push-button switch 22 is maintained depressed for a sufficient period of time, motor 44 comes up to its

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predetermined speed, for example 2,000 r.p.m., and centrifugal switch 60, mounted on the end of the rotor shaft 61, will be closed. At this time, the centrifugal switch 60 short circuits armature 33 and contact 34 and the push-button may be released. When the push-button 22 is released, the first relay winding 20 is de-energized and the armatures 30 and 33 will move to their open circuit position as indicated in FIGURE 1. When relay armature 30 moves to its open circuit position, winding 37 is de-energized. The armatures 38, 40 and 42 will remain in their solid line position because of the mechanical latching arrangement (not shown but previously described). Under these conditions, the light 58 will remain on and the motor 44 will continue to rotate until the door 120 has reached its terminal open position. When the door reaches its terminal open position as determined by a suitable obstacle, such as a bolt 140 on the track 122, the motor 44 can no longer maintain its rated speed and the centrifugal switch 60 will be opened.

Since the armature 42 of relay 36 is in contact with stationary contact 50, which stationary contact is connected directly to power input terminal 12, the light 58, which is connected to armature 42, will remain lit as long as the door is in its open position. It is, however, possible by momentarily actuating the push-button 22 to turn off the light 58 without operating the door 120. If the switch 22 is momentarily depressed for a period sufficient to energize winding 20 of relay 21, armature 30 is attracted to make contact with stationary contact 32 thus energizing winding 37 of relay 36. Since relay 36 is a stepping or a ratchet type relay, a single pulse of sufficient duration will cause the relay to step to its next, or other, position, namely, the dotted line position of the armatures shown in FIGURE 1. In the dotted line position, armature 42 is in contact with stationary contact 47. Since relay 21 is de-energized at the end of the short pulse, armature 33 moves to its open circuit condition and no current can flow to stationary contact 47 of relay 36, thus the light 58 will be turned off. Since the push-button switch is also released before the motor 44 could come up to speed and close centrifugal switch 60, the motor ceased to be energized when armature 33 of relay 21 was released. Similarly, the light may be turned on without operating the door by repeating the process of momentarily actuating switch 22 thereby momentarily energizing relays 21 and 36. Thus, armature 42 will again move to its solid line position thereby connecting the light 58 through stationary contact 50 to power input terminal 12. Again the motor will not reach a speed sufficient to actuate centrifugal switch 60 and therefore the door will not move appreciably from its terminal position.

If it is decided to close the door, the push-button 22 is depressed and held in this position until the motor 44 reaches the predetermined running speed required to close centrifugal switch 60. When relay 36 is energized by this last actuation of push-button 22, the armatures are stepped to their dotted line position. Current fed through armature 33 of relay 21 passes through stationary contact 49, armature 38, brushes 46 and 45 which connect the armature of motor 44, armature 40, stationary contact 51, field winding 54, and rheostat 56 back to terminal 10 of the power source.

When the push-button 22 is released after the motor has reached running speed, the circuits previously coupled through armature 33 will be coupled through centrifugal switch 60. Thus the light 58 will be energized through stationary contact 47 and armature 42 as long as the motor is running to drive the door to a closed position. When the door reaches its closed position, the motor will stall and centrifugal switch 60 will open, de-energizing the motor and the light 58. Thus the door is now in its closed position. All of the circuits are de-energized and the cycle is ready to be repeated.

Advantageously, the stalling and automatic de-energization of the motor when it reaches a terminal position constitutes a safety feature since the same operation will take place when the door strikes a person or an animal on the downward cycle or hits some obstruction within the garage such as misplaced pieces of lumber when moving to the opened position. In any of these instances, if the obstruction offers a sufficient increase on the load of the motor, the motor will stall and the door will stop through the release of centrifugal switch 60. The exact amount of load provided by the obstruction before the motor stalls is determined by rheostat 56, thus the rheostat controls both the motor speed by controlling the current through the motor field winding 54, and the sensitivity of the motor to stopping when an obstruction is engaged by the door. As indicated in FIGURE 2, the manual control knob 57 of rheostat 56 projects from the housing 70 to permit easy manual adjustment, thereby controlling motor speed and sensitivity to obstructions in a manner previously described. For optimum sensitivity, it is preferred to adjust rheostat 56 so that the motor field current is just sufficient to overcome the friction of the system in closing and opening the door. Advantageously, rheostat 46 also provides a handy means for compensating for the increased friction of the door mechanism such as occurs when the hardware begins to age.

Although the entire operation has been described in conjunction with push-button 22, the identical operation could have been achieved by a remote control device connected to plug 24, in FIGURE 1, selectively to actuate switch 28 in the remote control section to thereby control the energization of relay 21 in the same manner as was achieved by the push button 22.

This operator can be employed with other closure such as the torsion bar type often used for overhead garage doors. With this type of closure a sprocket and chain drive may be employed to couple the operator to the closure. The other features of the operator may be identical to those previously described with the exception of the connection between the torsion bar and the closure, which may be of a type well known in the art.

While I have shown and described one illustrative embodiment of this invention, it is understood that the principles thereof could be applied to other embodiments without departing from the spirit and scope of this invention.

What is claimed is:

1. In a closure operator, the combination of a first control circuit including voltage supply means, a normally open switch means connected across said voltage means, relay means for actuation by said voltage means through said switch means, a second control circuit including first contact means for connecting said second circuit to said first circuit upon energization of said relay means, a reversible motor, a normally open speed responsive switch to be actuated when said motor reaches a predetermined operating speed, two state switching means having contacts alternately positioned in the two states by successive operations of said relay means, means connected by said two state switching means for respectively operating said motor to close and open said closure in said alternate positions, and a third control circuit including a second contact means interconnected with said switching means for alternatively connecting and disconnecting said third circuit to and from said first circuit upon energization of said relay means, a lamp connected by said second contact means for energization when said switching means is in that alternate position where the motor is normally connected for opening the closure, whereby said lamp may be turned on and off in both closed and open positions of the closure by momentarily closing said switch means for a period less than the period required for said motor to reach said predetermined speed to thereby energize said third circuit but not said second circuit by preventing the closure of said speed responsive switch in said second circuit.

2. The combination of claim 1 wherein said third circuit is connected to said first circuit through said speed responsive switch whereby said lamp is energized whenever said motor is running at said predetermined operating speed.

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